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Issued December 14, 1909.

U. S. DEPARTMENT OF AGRICULTURE.

FARMERS' BULLETIN 382.

THE ADULTERATION OF FORAGE- PLANT SEEDS.

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1909.

LETTER OF TRANSMITTAL.

U. S. DEPARTMENT OF AGRICULTURE,
BUREAU OF PLANT INDUSTRY,
OFFICE OF THE CHIEF,
Washington, D. C., October 12, 1909.

SIR: I have the honor to transmit herewith and to recommend for publication as a Farmers' Bulletin a manuscript entitled "The Adulteration of Forage-Plant Seeds," prepared by Mr. F. H. Hillman, Assistant Botanist, and submitted by the Botanist in charge of the Seed Laboratory of this Bureau.

The adulteration of forage-plant seeds is a matter of great popular interest at the present time and the subject is treated in a practical manner in this bulletin.

Respectfully,

A. F. WOODS,
Acting Chief of Bureau.

HON. JAMES WILSON,
Secretary of Agriculture.

CONTENTS.

	Page.
Nature and forms of adulteration of seed	5
Ill effects of adulteration.....	6
Kinds of forage-plant seeds commonly adulterated and the adulterants used ...	7
Red clover seed.....	7
Alfalfa seed.....	8
Alsike clover seed.....	10
Orchard grass seed.....	11
Meadow fescue seed.....	12
Kentucky bluegrass seed.....	12
Redtop seed.....	13
Awnless brome-grass seed	14
Forage-plant seeds and their adulterants described.....	15
General characteristics.....	15
Red clover seed.....	16
Alsike clover seed.....	17
Alfalfa seed.....	17
Yellow trefoil seed.....	18
Bur clover seed.....	18
Sweet clover seed.....	19
Orchard grass seed.....	19
Meadow fescue, or English bluegrass, seed	19
English rye-grass seed.....	19
Italian rye-grass seed.....	20
Awnless brome-grass seed.....	20
Chess, or cheat, seed	20
Kentucky bluegrass seed.....	20
Canada bluegrass seed.....	21
How to test seed for adulterants.....	21
Summary.....	23

ILLUSTRATIONS.

	Page.
FIG. 1. Mixture of seeds of red clover and yellow trefoil.....	7
2. Mixture of seeds of alfalfa and yellow trefoil.....	8
3. Mixture of seeds of alfalfa, toothed bur clover, and spotted bur clover..	9
4. Mixture of seeds of alfalfa and sweet clover.....	9
5. Mixture of weed seeds commonly found in low-grade alsike clover seed.	10
6. Mixture of seeds of orchard grass, meadow fescue grass, and English rye-grass.....	11
7. Mixture of seeds of Kentucky bluegrass and Canada bluegrass.....	13
8. Seeds of redtop representing the "fancy" grade of the trade.....	13
9. Chaff of redtop seed.....	14
10. Seeds of timothy.....	14
11. Mixture of seeds of awnless brome-grass, meadow fescue, English rye- grass, and chess, or cheat	15
12. Seeds of red clover.....	16
13. Alsike clover seeds.....	17
14. Alfalfa seeds.....	17
15. Plump and shriveled alfalfa seeds.....	18
16. Seeds of yellow trefoil.....	18
17. Seeds of sweet clover.....	19
18. Magnifying glass.....	22
19. Homemade seed tester.....	22

THE ADULTERATION OF FORAGE-PLANT SEEDS.

NATURE AND FORMS OF ADULTERATION OF SEED.

Farm seed is considered to be adulterated when it contains seed of inferior kind or quality in excessive quantity. When inferior seed is present in considerable quantity it is naturally presumable that intentional adulteration has been practiced.

The misbranding of seed, or its sale under the name of a different kind, may be intentional or it may be the result of error in labeling. Its effect, however, so far as the purchaser is concerned, is the same as adulteration.

Some of the plants whose seeds are used as adulterants have more or less forage value and are widely distributed in agricultural regions where farm seeds are produced. For this reason a comparatively small quantity of their seed is likely to appear in seed crops merely as an incident to the culture of these crops. When the small extent of such incidental occurrence is conspicuously exceeded, intentional adulteration is strongly suggested. An illustration of this is seen in the relation of yellow trefoil to red clover and alfalfa. The trefoil grows spontaneously in most regions where red clover seed and alfalfa seed are produced, and some trefoil plants are likely to appear in these crops. While trefoil is a low-growing plant, mostly escaping the mower when the crop is cut, some fruiting stems are likely to be harvested with the crop. The admixture of the trefoil seed with that of the crop is further aided by the fact that the trefoil has a long seeding period, and consequently its seed may appear in clover or alfalfa seed harvested at any time within the usual period during which harvesting may occur. Thus the appearance of a trace of trefoil in red clover or alfalfa seed does not indicate intentional or serious adulteration. Again, while Canada bluegrass grows spontaneously with Kentucky bluegrass it matures so much later than the latter that only very immature seed can appear incidentally in the harvested Kentucky bluegrass seed. The latter, however, as offered to the trade often contains mature Canada bluegrass seed in quantity varying from 10 per cent to complete substitution. This is evidently intentional adulteration.

As a rule, successful seed adulteration is made possible by the similarity existing between the inferior seed and that of the crop seed with which it is used. It often happens, therefore, that the adulterant used is the seed of some plant very closely related to the adulterated crop seed. The dealer who adulterates seed bases his faith

in the success of the deception upon the very careless examination made or the absence of any examination of the seed by the average purchaser, including the majority of retail dealers. If, before purchasing, a careful examination of the seed offered for sale was made by all buyers, guided by a knowledge of the various adulterants used, seed adulteration would soon cease.

The combination of seeds of standard farm crops commanding uniformly different prices in the seed market constitutes adulteration when the mixture is sold at the price of the more expensive seed. This is illustrated by the combination of redtop and timothy offered as redtop.

Another form of adulteration is the use of dead seed of the kind offered for sale. Such dead seed may have lost its vitality from advanced age or from unfavorable conditions of harvesting or of storage, or it may consist of light screenings in which the seed germs never developed. (See fig. 15.) Old seed having very low vitality or none at all doubtless is often offered for sale. Considerable worthless shriveled red clover and alfalfa screenings are imported each year for use in adulterating red clover and alfalfa seed.

One of the commonest and most objectionable forms of adulteration is the use of low-grade screenings, consisting chiefly of miscellaneous weed seeds. (See fig. 5.) In many instances such adulterants have been purchased in foreign countries. The statement, often made, that low-grade weedy screenings are imported for the purpose of recleaning before being marketed is without foundation, because the quantity of good seed to be secured would cost the dealer more, usually very much more, than the same quantity of good seed produced in this country. Such low-grade seed, therefore, is unquestionably imported exclusively for use either in competition with or as an adulterant of higher grade seed.

ILL EFFECTS OF ADULTERATION.

Not all the consequences experienced by the consumer which arise from seed adulteration can be anticipated, but chief among the disadvantages are a reduced stand of the desired crop, a monetary loss in paying too much for the quantity of good seed actually secured, a loss in connection with transportation charges, which are higher than they should be for the actual quantity of good seed transported, and the securing of an undesired crop which, if from miscellaneous screenings, may do permanent injury to the farm owing to the noxious weeds introduced. Many indirect losses and disappointments resulting from the use of adulterated seed are experienced by progressive farmers who may unwittingly sow such seed.

KINDS OF FORAGE-PLANT SEEDS COMMONLY ADULTERATED AND THE ADULTERANTS USED.

The kinds of forage-plant seeds most subject to adulteration are red clover, alfalfa, alsike clover, orchard grass, meadow fescue, Kentucky bluegrass, redbtop, and awnless brome-grass.^a The character and extent of the adulteration vary with the kind of seed and the conditions of culture of the crop producing it.

RED CLOVER SEED.

Red clover seed is adulterated with imported yellow trefoil, which resembles the clover seed very closely and may easily escape detection. (See fig. 1.) A small quantity of trefoil may appear incidentally in the clover seed. In cases of adulteration, 30 to 40 per cent, or even 50 per cent, of the bulk may consist of trefoil.

The mixing of trefoil seed with better seed has practically all been done in this country. The development of public interest in the matter of seed impurities made within recent years, together with the publication of the names of dealers found to be handling adulterated seed, has resulted in a marked reduction in the importations

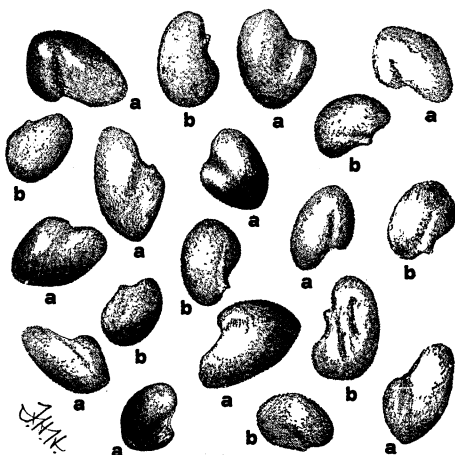


FIG. 1.—Mixture of seeds of red clover (a) and yellow trefoil (b). The clover seeds are more or less triangular, those of trefoil oval and usually with a distinct projection beside the scar notch. (Enlarged.)

of trefoil seed. A corresponding decrease in the quantity of red clover seed adulterated with trefoil has been observed. Tests of red clover seed made at the Seed Laboratory of this Department show that trefoil is used as an adulterant in variable quantities, sometimes exceeding 50 per cent. In the majority of cases it has amounted to over 20 per cent. The close similarity between trefoil seed and red clover seed renders detection of the trefoil by the average purchaser improbable unless sought especially with the aid of a magnifier.

The substitution of clover seed from the warmer parts of Europe for American-grown seed, which may be higher priced, amounts to adulteration, since it has been shown by various experiments that such seed is inferior to northern-grown American seed for crop

^a Awnless brome-grass is also known as *Bromus inermis*, Hungarian brome-grass, smooth brome-grass, and brome-grass.

production in the Northern States. This form of adulteration is indicated by the presence of an unusual quantity of very small clover seeds and by the kinds of weed seeds present.

The presence of a large proportion of very small clover seeds from any source is equivalent to adulteration, since the crop-producing power of small seed is known to be inferior to that of large, well-filled seed.

The use of old seed having low vitality is a common form of adulteration and is influenced very largely by the extent of the surplus stocks of seed held from year to year by retail dealers. This form of adulteration should be easily detected through the contrast between old seed and new seed of clover.

No class of seed is so subject to adulteration with low-grade, weedy screenings as that of red clover. Some of these screenings may be of home production, but they often are imported as second and third grades of seed. The use of screenings doubtless has been the most prolific means of weed dissemination in this country.

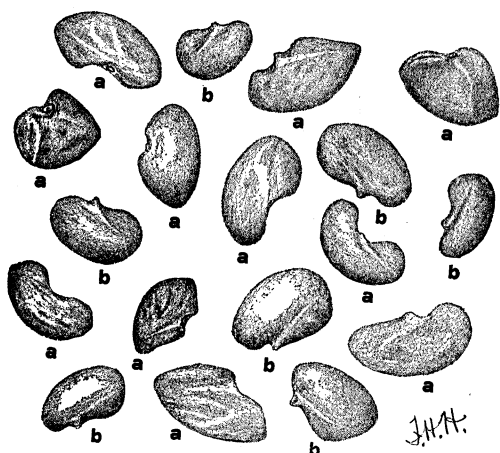


FIG. 2.—Mixture of seeds of alfalfa (a) and yellow trefoil (b). Alfalfa seeds are more or less kidney shaped or angular, while those of trefoil are more uniformly oval and have the small projection at the scar more commonly evident. (Enlarged.)

ALFALFA SEED.

Alfalfa seed is adulterated with trefoil essentially the same as in the case of red clover seed. The presence of the trefoil

seed is even more obscured by the color of the alfalfa than by the color of red clover seed, and its detection is correspondingly less probable. (See fig. 2.) Tests of alfalfa seed made at the Seed Laboratory show that excessive quantities of trefoil, mostly over 35 per cent and sometimes over 50 per cent, are employed in adulterated lots. A decline in the quantity of alfalfa seed now adulterated with trefoil is observable, as in the case of red clover seed.

The seed of two kinds of bur clover has been employed to some extent in adulterating alfalfa seed. (See fig. 3.) The mixing appears to have been done in Europe, where the bur clover seed is a by-product of carding machines operating on Chilean wool. Alfalfa seed thus adulterated has been imported and widely distributed among retail dealers in this country. The quantity of bur clover seed employed is usually less than that used in the case of trefoil. In

most instances observed it has been less than 6 per cent, but in some it has been over 10 per cent, reaching nearly 17 per cent in one instance and nearly 21 per cent in another. It is a noticeable fact that alfalfa seed adulterated with bur clover is usually adulterated also with trefoil.

The seed of sweet or Bokhara clover is sometimes to be considered in connection with the adulteration of alfalfa seed. Sweet clover is common along the irrigation ditches of the western alfalfa fields and small quantities of its seed frequently occur incidentally in

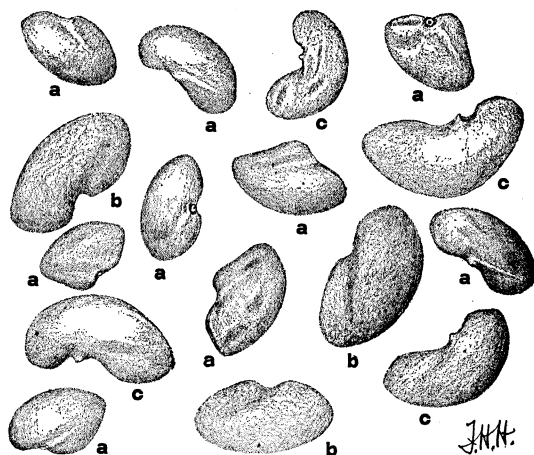


FIG. 3.—Mixture of seeds of alfalfa (a), toothed bur clover (b), and spotted bur clover (c). Note the larger size of the bur clover seeds, also the kidney shape of the spotted bur clover seeds, which have the scar near the smaller end. (Enlarged.)

American-grown alfalfa seed. Tests at the Seed Laboratory show that a trace of sweet clover is commonly found in alfalfa seed grown

in the Western States. It is sometimes present to the extent of 3 per cent or even 5 per cent. Either of these percentages may be the result of intentional adulteration. (See fig. 4.)

The use of old alfalfa seed is practiced to some extent in adulterating new alfalfa seed, but its presence should be readily observed owing to the contrast between the colors of old and new seed.

The light, shriveled alfalfa screenings im-

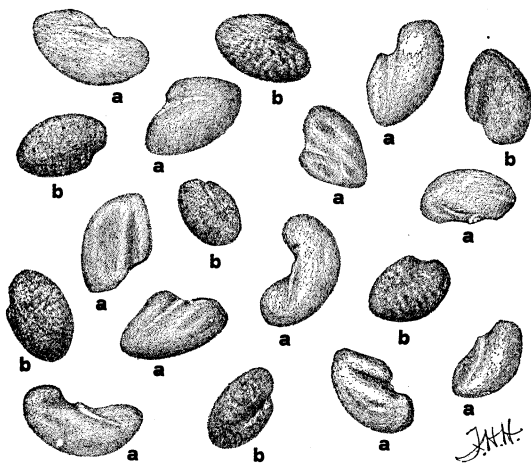


FIG. 4.—Mixture of seeds of alfalfa (a) and sweet clover (b). The elliptical form of the sweet clover seeds, which have the scar notch near one end, together with their uneven surfaces, serves to distinguish them from the more kidney-shaped alfalfa seeds. (Enlarged.)

ported for the purpose of adulteration are totally worthless, since the seed germs are imperfectly developed. The shriveled appearance

and dull, dark-brown color of this seed clearly distinguish it from fresh, well-filled seed. (See fig. 15.) When used it forms but a part of a sample of the adulterated seed, and for this reason may pass unnoticed in casual observation.

Much of the cheaper imported alfalfa seed which may be used in adulteration carries many kinds of pernicious weed seeds which should not be introduced to localities where alfalfa is still an experimental crop.

ALSIKE CLOVER SEED.

The adulteration of alsike clover seed is confined chiefly to the use of low-grade, weedy screenings. (See fig. 5.) The use of such

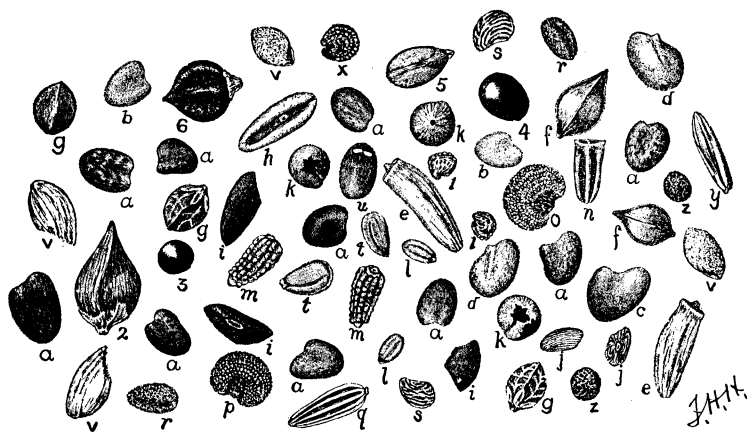


FIG. 5.—Mixture of weed seeds commonly found in low-grade alsike clover seed: *a*, alsike clover; *b*, white clover; *c*, red clover; *d*, yellow trefoil; *e*, Canada thistle; *f*, dock; *g*, sorrel; *h*, buckhorn; *i*, rat-tail plantain; *k*, lamb's-quarters; *l*, shepherd's-purse; *m*, mayweed; *n*, scentless camomile; *o*, white campion; *p*, night-flowering catch-fly; *q*, oxeye daisy; *r*, small-fruited false flax; *s*, cinquefoil; *t*, two kinds of peppergrass; *u*, catnip; *v*, timothy; *x*, chickweed; *y*, Canada bluegrass; *z*, clover dodder; *1*, mouse-ear chickweed; *2*, knot-grass; *3*, tumbling amaranth; *4*, rough amaranth; *5*, heal-all; *6*, lady's-thumb. (Enlarged.)

material is favored by the dark color and small size of the alsike seeds. For this reason many kinds of small weed seeds are obscured and therefore overlooked by the indifferent purchaser. Various evidences of the importation of such screenings have been observed at the Seed Laboratory.

Canadian-grown alsike seed often contains considerable trefoil seed, since the trefoil plants are common in the fields of alsike. The lighter color and larger size of the trefoil seeds render them easily observed when mixed with alsike. (Compare figs. 13 and 16.) If trefoil is present in considerable quantity in alsike seed, either adulteration or incomplete cleaning is indicated.

Since alsike clover and timothy ripen at about the same time, mixed stands yield a mixed seed crop. Most of the timothy can be

separated from the alsike, but mixed lots often pass in the trade as alsike seed. While a timothy and alsike mixture may not be objectionable as a crop in some instances, the timothy amounts to an adulterant when the mixture of seed is sold at alsike seed prices, which are three or four times higher than those of timothy.

ORCHARD GRASS SEED.

The adulteration of orchard grass seed is accomplished chiefly by the use of meadow fescue or English rye-grass seed, or both. (See fig. 6.) Each of those kinds of seed is cheaper than pure orchard

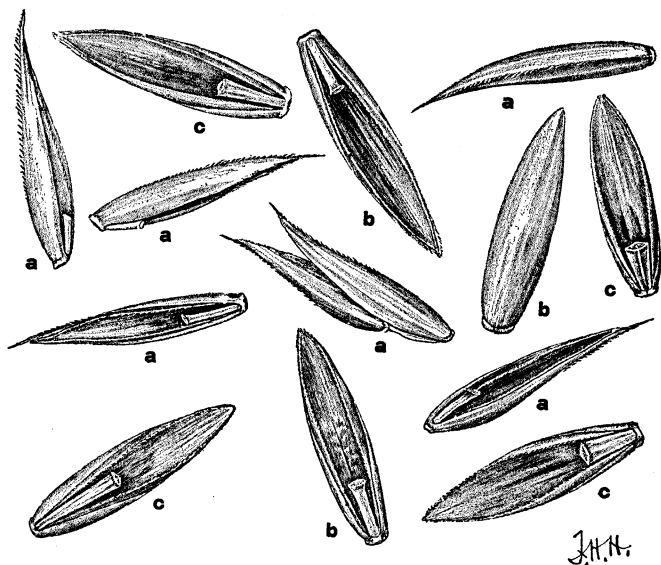


FIG. 6.—Mixture of seeds of orchard grass (a), meadow fescue grass (b), and English rye-grass (c). The orchard grass seeds are distinguished from the others by their slender, curved form. The meadow fescue and rye-grass seeds are distinguished by the difference in the section of the seed-cluster axis (rachilla segment) which each bears. (Enlarged.)

grass seed. Meadow fescue seed sells at one-half to two-thirds the price of orchard grass, while rye-grass varies in price from one-third to one-half that of orchard grass. The close similarity of the seeds of these three grasses makes this a popular form of adulteration. Distinguishing differences between the kinds are readily disclosed, however, by careful examination under a lens. Tests of 265 samples of orchard grass seed made at the Seed Laboratory in 1905 showed 133 samples, or slightly over one-half of those tested, to contain one or both of these adulterants. Of the adulterated samples 59 contained 25 per cent or over of the adulterant and 7 were adulterated to the extent of one-half or over. The fact that 24

States were represented by the samples tested showed the wide extent of this adulteration in the retail trade at the time mentioned.

It is gratifying to note that tests covering 343 samples sold as orchard grass in 1908 showed but 53 samples, or 15.45 per cent, to be adulterated. In these cases meadow fescue and English rye-grass seed were chiefly employed. In two instances chess seed was used, amounting to nearly 18 per cent in one case and nearly 23 per cent in the other. In one instance over 21 per cent of the sample consisted of Canada bluegrass seed.

Chaff screenings containing little matured orchard grass seed but having the appearance of good seed make up a considerable part of some lots of seed. Such seed is essentially adulterated, and, furthermore, as a rule the screenings carry various weed seeds.

MEADOW FESCUE SEED.

Chess, or cheat, is one of the commonest impurities of meadow fescue seed, varying in quantity from a trace to 5 per cent or over. (See fig. 11, *b, d.*) One sample examined at the Seed Laboratory contained over 16 per cent of chess; three others contained over 19 per cent. In each of these four instances adulteration was suggested not only by the large quantities of chess but also by the presence of English rye-grass seed, which is sometimes used as an adulterant of meadow fescue seed. (See fig. 11, *b, c.*) In one of these cases over 62 per cent of the lot consisted of English rye-grass seed. The mistaking and substitution of chess for meadow fescue seed is mentioned in Press Bulletin No. 25 from the Nebraska experiment station; also in Kansas station Bulletin No. 141.

While meadow fescue seed is cheaper than that of orchard grass and is used as an adulterant of the latter, it often contains orchard grass seed, sometimes in considerable quantity. Old, worthless orchard grass seed or screenings being cheaper than the fescue seed may be used in adulterating the latter.

KENTUCKY BLUEGRASS SEED.

The chief adulterant of Kentucky bluegrass seed is the seed of Canada bluegrass, so called because it is produced chiefly in Canada. This is an inferior kind of true bluegrass not adapted to the purposes or crop requirements of Kentucky bluegrass. It grows spontaneously, however, throughout the eastern United States. It often appears in crops of Kentucky bluegrass harvested for seed. Since the Canada bluegrass matures its seed several weeks later than the Kentucky bluegrass its mature seed does not appear in the Kentucky bluegrass seed crop as it is ordinarily harvested. Immature Canada bluegrass chaff sometimes appears, however, in chaffy samples of

Kentucky bluegrass seed. Most, if not all, of the Canada bluegrass seed used in the trade is imported from Canada. As there is very little legitimate demand for it these importations are mostly for use in adulteration. The close resemblance existing between the seeds of these two bluegrasses permits the complete substitution of the inferior kind for the other with little danger of detection by purchasers. (See fig. 7.) The seed of Canada bluegrass costs from one-third to one-half as much as Kentucky bluegrass seed.

Tests made at the Seed Laboratory and at various experiment stations show that much adulterated Kentucky bluegrass and Canada bluegrass seed substituted for Kentucky bluegrass seed is on the market. Of 251 samples of seed sold as Kentucky bluegrass which were examined at the Seed Laboratory in 1905, 41 samples, or over 16 per cent, were found to be adulterated with Canada

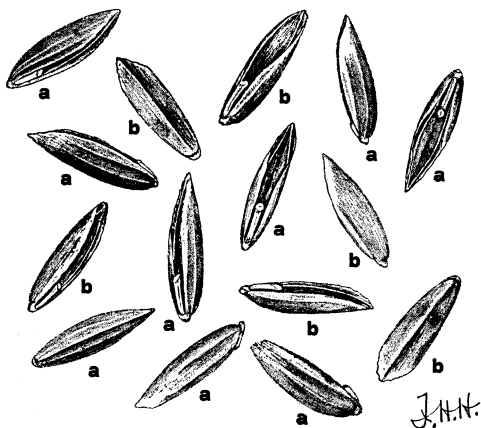


FIG. 7.—Mixture of seeds of Kentucky bluegrass (a) and Canada bluegrass (b). The Kentucky bluegrass seeds are broadest at the center, pointed, and have a distinct ridge on each side. Canada bluegrass seeds are mostly broadest near one end, blunt, and smooth on the sides. (Enlarged.)

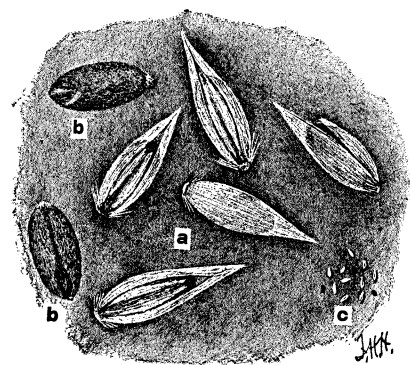


FIG. 8.—Seeds of redtop representing the "fancy" grade of the trade: a, different views of seeds having the white, papery, inner chaff; b, two views of a grain, or kernel, with the inner chaff removed; c, the same, natural size.

bluegrass seed. Tests of 357 samples of seed sold as Kentucky bluegrass seed in 1908 showed 39 samples, or nearly 11 per cent, to be adulterated or misbranded. In 14 of these samples other seed had been substituted for the proper seed, Canada bluegrass seed being used in 12 instances and meadow fescue, or English bluegrass, seed in the other 2.

Poorly cleaned Kentucky bluegrass seed is likely to contain much light chaff devoid of seed. The deceiving nature of such chaff renders its use equivalent to adulteration.

The careless methods employed in curing Kentucky bluegrass seed followed by some producers results in killing much of the seed by overheating. Since such dead seed maintains the weight of good

seed it can readily be mixed with the latter, when its detection, unless by its musty odor, can be accomplished only by making a germination test.

REDTOP SEED.

The seed of redtop appears on the market in two distinct grades under the trade names "fancy," "choice," or "recleaned" (fig. 8) and "chaffy" or "unhulled" (compare figs. 8 and 9). The chaffy grade is variable in quality, sometimes containing very little good seed. Its misleading character is sufficient to make it equivalent to an adulterant in some instances.

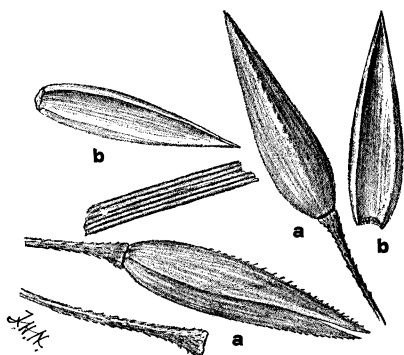


FIG. 9.—Chaff of redtop seed: *a*, whole spikelets usually devoid of seed in "chaffy" grades; *b*, separated scales of the same; *a* and *b* represent the outer chaff of the seed. (Enlarged.)

selection of samples marked "fancy" or "choice" and found to contain timothy showed this adulterant present in amounts varying from nearly 10 per cent to over 22 per cent. This grade of redtop should be practically free from timothy and chaff.

AWNLESS BROME-GRASS SEED.

Awnless brome-grass seed is sometimes adulterated with either meadow fescue seed or with the seed of chess, or cheat. (See fig. 11). In some cases both kinds are present. Press Bulletin No. 25 from the Nebraska experiment station states that chess is sometimes substituted for brome-grass seed. Tests at the Seed Laboratory show that chess is frequently present in brome-grass seed in quantities varying from a trace to over 5 per cent. It has been found to amount to 17 per cent of the total bulk. While a relatively high percentage of the chess may occur incidentally, intentional adulteration is sometimes indicated.

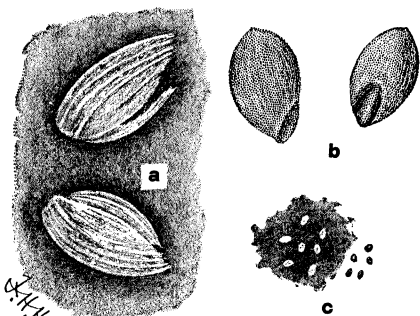


FIG. 10.—Seeds of timothy: *a*, grains in the hull, or chaff; *b*, grains removed from the chaff; *c*, the same, natural size.

Meadow fescue seed is a common impurity of brome-grass seed, often exceeding 5 per cent. In instances observed at the Seed Laboratory it amounted to 12 and 19 per cent, respectively. In

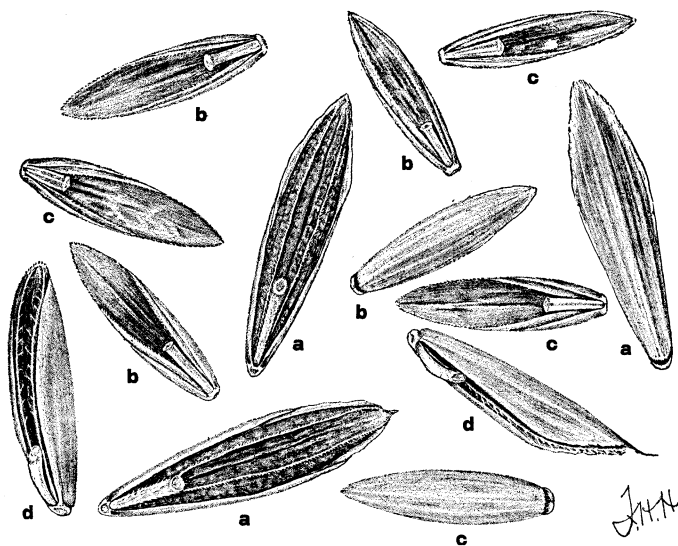


FIG. 11.—Mixture of seeds of awnless brome-grass (a), meadow fescue (b), English rye-grass (c), and chess, or cheat (d). The brome-grass seeds are distinguished by their greater length and flattened form. The seeds of chess (d) are somewhat cylindrical, due to being folded lengthwise. They are thus thicker than the awnless brome-grass seed and sometimes are awned. (Enlarged.)

another instance meadow fescue and English rye-grass seed together amounted to over 24 per cent of the lot. Meadow fescue may occur incidentally in the seeding crops of bromé-grass, but the large quantities of seed mentioned amount to adulteration.

FORAGE-PLANT SEEDS AND THEIR ADULTERANTS DESCRIBED.

GENERAL CHARACTERISTICS.

The seeds of the more common forage plants represent two general groups of plants—legumes and grasses. The same is true of most of the adulterants used.

Leguminous seeds of this class are mostly free from the pod or other covering. Their surface is usually smooth and the form is largely dependent on the shape of the contained germ or embryo, which consists chiefly of a stemlet bearing a root tip and a pair of fleshy seed leaves, or cotyledons. The embryo is folded upon itself, the stemlet being bent over against the edges of the two cotyledons.

A notch on the edge of the seed and between the ends of the folded embryo contains the seed scar. (See fig. 12.)

Seeds of grasses are more complex and variable in structure. They usually consist of two or more scales constituting most of the "chaff" surrounding the kernel, or grain, which contains the germ. (Compare figs. 6 to 11, inclusive.) The chaff scales immediately surrounding the grain have the characters which indicate the kind to which the seed belongs. In some grasses the kernel, or grain, separates more or less readily from the chaff, as in redtop and timothy. (See figs. 8 and 10.) In such grass seeds as those of orchard, fescue, and rye grasses the chaff persists and marks the different kinds by its form and structure.

Most of the grass seeds subject to adulteration have the kernel, or grain, surrounded by only two scales, one larger than the other

and called the lemma. The lemma has more or less distinct nerves or veins along its back or convex face. It may have a bristle, or awn, projecting from the apex in certain kinds. Some oat seeds have such an awn projecting from near the middle of the back. The lemma incloses a smaller, thin, two-veined scale called the palea, or palet. The grain lies between the lemma and the palet. At the base of the palet in such grasses as orchard

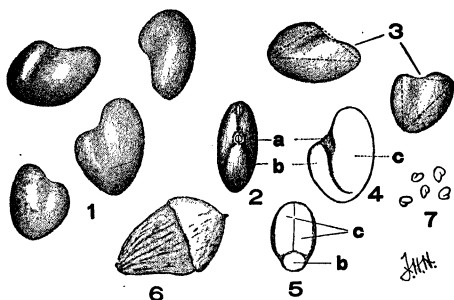


FIG. 12.—Seeds of red clover: 1, side view and, 2, edge view of seeds; 3, the triangular form indicated; 4, a seed cut lengthwise; 5, a seed cut crosswise, showing the embryo; a, a seed scar; b, a stemlet (radicle) of the embryo; c, seed leaves (cotyledons) of the embryo; 6, a pod of red clover; 7, natural size of seeds.

grass, fescue grass, rye-grass, and the bluegrasses is a short appendage, the rachilla segment. It is a section or "joint" of the axis of the flower and seed cluster of the grass. The form of the segment differs somewhat in the seeds of different grasses. In redtop and timothy the rachilla segment is absent. The color of most of the grass seeds of this class varies from light-straw color to light brown.

These general characteristics of leguminous and grass seeds are those to be observed when examining such seeds under a magnifier for adulterants.

The principal characteristics by which this class of seeds and their adulterants may be distinguished are stated in the following descriptions.

Red Clover Seed.

The seed of red clover may be distinguished from other leguminous seeds by its color. Some seeds are violet, others light yellow, and others variegated in having both colors. Individual seeds are flattened and somewhat triangular, with rounded angles. (See fig. 12.)

New seed is clear and bright and has a slight luster; old seed becomes dull and reddish brown.

Effort is sometimes made to give old, dead seed an appearance of newness by oiling and rubbing the seed. Such treated seed has an unnaturally high luster, but the fresh violet and yellow colors are not recovered. An unusually high luster, therefore, indicates adulteration.

The size of individual seeds in any sample of red clover seed shows considerable variation. When all the seed or a considerable part of it consists of very small seeds it may be considered as inferior. The largest seed now found on the market is that imported from Chile. The smallest is the low-grade seed brought from Europe.



FIG. 13.—Alsike clover seeds: *a*, seeds showing variation in form and surface appearance, enlarged; *b*, natural size of seeds.

Alsike Clover Seed.

The conspicuous green color of alsike seed distinguishes it from the seed of other clovers. Some seeds are very dark green, while others are light olive-green and somewhat mottled. Old seed becomes brown. The seeds are smaller than those of red clover and somewhat oval heart shaped in outline. The form is practically the same as that of white clover seed, which is yellow or reddish yellow. (See fig. 13.)

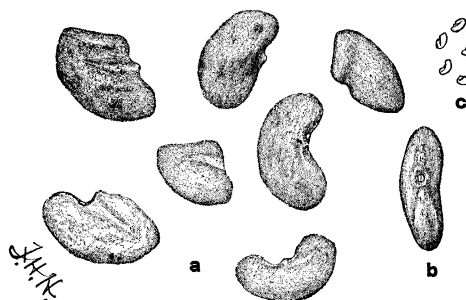


FIG. 14.—Alfalfa seeds: *a*, individual seeds, showing variation in form; *b*, edge view of a seed, showing the scar; *c*, natural size of seeds.

Alfalfa Seed.

Considerable variation in the form of alfalfa seeds is observable, due to the fact that several seeds are produced in each pod. The somewhat kidney-shaped form of these seeds readily distinguishes them from the

true clover seeds. Some seeds are somewhat triangular. The greenish yellow color, together with the usually evident light stripe leading from the scar toward one end, distinguishes alfalfa seeds from other crop seeds. The seed scar is near the center of the seed. Some of the more kidney-shaped seeds have a projecting point beside the scar marking the position of the root tip of the embryo. (See fig. 14.) Well-developed alfalfa seed is well filled and plump.

Poorly developed seeds contain a thin, shriveled germ and so are thin and wrinkled. Such seeds are, however, often even longer and broader than plump seeds, but the thin and wrinkled appearance, together with the usually dull-brown color, readily indicates inferiority. (See fig. 15.)

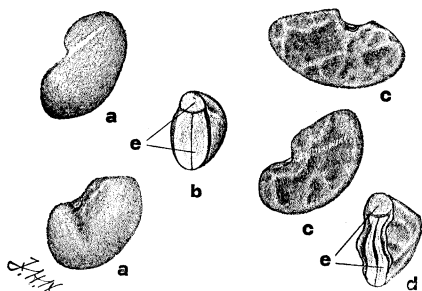


FIG. 15.—Plump and shriveled alfalfa seeds: *a*, well-filled, plump seeds; *b*, cross section of a well-filled seed, showing the thick embryo (*c*); *c*, shriveled seeds, thin and having a wrinkled seed coat; *d*, cross section of a shriveled seed, showing the thin, worthless embryo (*e*). (Enlarged.)

indicating the root tip of the embryo is nearly always evident. This, together with the oval form and the absence of violet, renders trefoil easily distinguishable from red clover seed. The form of the trefoil alone distinguishes it from alfalfa seed, barring occasional seeds of either kind which may be very similar to those of the other. No difficulty should be experienced in distinguishing trefoil seed when used as an adulterant of alfalfa seed. (See fig. 16.)

Bur Clover Seed.

The seed of bur clover is closely related to alfalfa seed and is also very similar to it. Two kinds, toothed and spotted bur clover, are involved. The seed of toothed bur clover is somewhat kidney shaped or oval, as shown at *b*, figure 3. These seeds are mostly longer than alfalfa seeds and have a dull, yellowish or light-brown surface. The notch at the scar is usually prominent and the root tip does not project as a pointed protuberance. Seeds of spotted bur clover, shown at *c*, figure 3, are more commonly kidney shaped, sometimes conspicuously so. Some of them are longer than alfalfa seeds, while many are about the same size

Yellow Trefoil Seed.

Yellow trefoil seed is about the same size as that of red clover and alfalfa. Its color is near that of alfalfa seed and the lighter yellow clover seeds. The seeds are oval, or egg shaped, in outline and slightly notched at the scar near the smaller end. A slight projecting point, or protuberance, beside the scar indicating

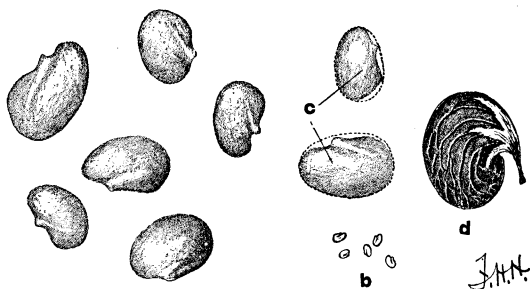


FIG. 16.—Seeds of yellow trefoil: *a*, seeds showing variation in form and size; *b*, natural size of seeds; *c*, oval form of trefoil seeds indicated; *d*, a pod of trefoil.

or smaller. The protuberant root tip is usually clearly evident and noticeably nearer one end of the seed than in alfalfa seed. Some of these seeds are dull, others possessing a bright, fresh appearance. The seeds of this kind are mostly light yellow.

Sweet Clover Seed.

The seeds of sweet clover are very uniformly elliptical in general outline, the scar notch being near one end. The seeds are about the size of those of red clover and alfalfa. The color is yellowish brown and the rather dull surface is slightly uneven. The form and surface appearance must be depended upon in detecting free seeds of sweet clover mixed with alfalfa seed. If 5 to 10 per cent, or over, of a sample consists of sweet clover seed, its characteristic odor becomes evident. In nearly all cases of the presence of sweet clover in excess of a trace, a few of the unopened pods of this clover accompany the seed. The pods inclose a single seed and are rough, due to a coarse network of ridges. The color varies from light brown to dark brown. (See fig. 17.)

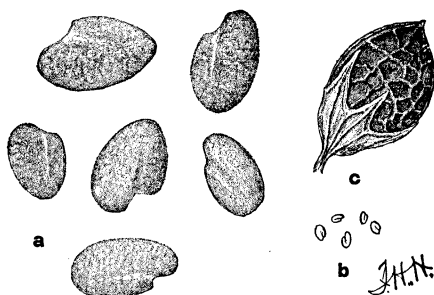


Fig. 17.—Seeds of sweet clover: *a*, seeds showing variation in form and size; *b*, natural size of seeds; *c*, a pod of sweet clover.

Orchard Grass Seed.

Orchard grass seed is to be distinguished by the characteristic form of the individual seeds, which differs from that of other seeds. These seeds are lance shaped, tapering to an awn-pointed apex, which is bent to one side. The back of the lemma is sharply angled, the angle being more or less hairy, especially toward the apex. (See fig. 6, *a*.)

Meadow Fescue, or English Bluegrass, Seed.

Meadow fescue seeds are larger than orchard grass seeds, straight, and broadly lance shaped or boat shaped. The apex is not awned. The back of the lemma is rounded instead of angled, as in orchard grass. The rachilla segment is cylindrical, nearly straight, and abruptly expanded at the apex. The form of the segment distinguishes this seed from that of English rye-grass. (See fig. 6, *b*, and fig. 11, *b*.)

English Rye-Grass Seed.

The seed of English rye-grass is very similar in general appearance to that of meadow fescue. The form and size of individual seeds are

essentially the same as in the fescue seed. A distinguishing difference appears, however, in the form of the rachilla segment, which is flattened, wedge shaped, and expanded but very slightly, if at all, at the apex. (See fig. 6, *c*, and fig. 11, *c*.)

Italian Rye-Grass Seed.

The seed of Italian rye-grass may be distinguished, as a rule, from English rye-grass seed by the presence of a slender awn from the apex of the lemma. Some of the seeds of this grass are devoid of the awn. The rachilla segment in Italian rye-grass seed is generally a little narrower than that of English rye-grass.

Awnless Brome-Grass Seed.

The seeds of awnless brome-grass are larger than those of the other grasses discussed. They are broadly lance shaped and much flattened, being relatively thinner than other grass seeds. The papery apex is acute or sometimes has a short awn. The palet is exposed and exhibits two slender veins, and usually a slender groove along its center, in ripe seeds. The dark-colored grain is evident through the palet. These seeds are mostly light brown. (See fig. 11, *a*.)

Chess, or Cheat, Seed.

Chess seeds are robust and more or less folded cylindrically. The back is rounded and the inner face bearing the palet is deeply grooved. The apex usually bears a short awn which readily breaks away. The palet veins are coarsely hairy, while in awnless brome-grass seed they are very finely hairy. The rachilla segment is club shaped and curved. (See fig. 11, *d*.)

Kentucky Bluegrass Seed.

The seed of Kentucky bluegrass is marketed "in the chaff," but the methods of cleaning the seed used in localities of large production should remove all superfluous chaffy material, including undeveloped light seed, leaving the individual seeds in essentially the condition shown in figure 7. This seed in bulk has a light-brown color, which is darkest in the best-cleaned pure seed. Light-weight chaff lightens the general color of the seed in bulk. The identity of this seed can be determined with certainty only when examined under a lens. Three characteristics of structure serve to distinguish this seed with certainty. They are as follows: Form, distinctness of veins of the lemma, and the coarseness of the hairs on the veins of the palet. These seeds are somewhat canoe shaped, the back of the lemma being sharply keeled. The apex of the lemma of the seed is usually pointed

if not broken away in the process of cleaning for market. The seed is therefore broadest at the middle, which is the characteristic form of this seed. (See fig. 7, *a*.) Each lateral half of the lemma bears a distinct vein forming a ridge parallel with the keel of the lemma. The appearance of these veins, called lateral or intermediate veins, is very characteristic of Kentucky bluegrass seed. The hairs on the veins of the palet are relatively few and coarse in this seed. They can be distinguished only by means of a good magnifier or a microscope. This character does not need to be considered in ordinary cases of adulteration, since the form of the seed and the distinctness of the intermediate veins are sufficient.

Canada Bluegrass Seed.

Canada bluegrass seed is generally lighter colored in bulk than Kentucky bluegrass seed. Since the Canada thistle is very common in southern Canada this grass seed usually contains numerous prickles of the thistle. Some seedsmen depend upon the color of the seed and the presence of the prickles to distinguish Canada bluegrass seed. This is unreliable, since the color varies and the similar prickles of horse nettle are common in pure Kentucky bluegrass seed. This seed is to be distinguished from that of Kentucky bluegrass by the broader form of individual seeds, indistinct veins, and numerous fine hairs on the palet veins. The apex of the lemma is often papery and rounded and somewhat flaring. The seed is therefore very often broader above than at the middle. (See fig. 7, *b*.) The lateral veins are very indistinct or apparently absent, giving the side of the seed a smooth, rounded appearance. The hairs on the palet veins are very numerous and fine. The form and indistinct veins as observed under a magnifier suffice to distinguish this seed in cases of adulteration. A few seeds having much the same form as Kentucky bluegrass seeds are to be found in all samples of Canada bluegrass seed, but sufficient seed similar to that shown in figure 7, *b*, is always present in samples and is readily distinguishable under the magnifier.

HOW TO TEST SEED FOR ADULTERANTS.

It is to be observed from the preceding statements relating to the various seed adulterants that in some instances the general appearance of the small bulk sample is evidently influenced by the presence of the adulterant, as in the use of trefoil in red clover, shriveled screenings in alfalfa seed, or weedy screenings in any of the farm seeds. The detection of specific kinds of adulterant seeds, however, usually requires the use of a magnifier or lens.

The most convenient magnifier for this purpose is, doubtless, the tripod magnifier shown in figure 18. It costs from 50 to 75 cents and is usually obtainable from opticians or manufacturers of optical goods.

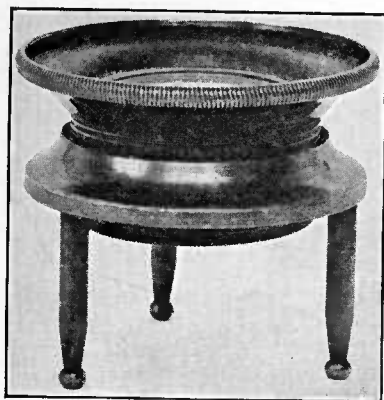


FIG. 18.—Magnifying glass.

Seed to be examined for adulterants should be spread thinly on white paper so that individual seeds may be examined critically. The foregoing descriptions and illustrations should suffice to enable one to recognize the common crop seeds and their adulterants.

The relative proportion, or the percentage, of adulteration can be practically determined by counting out 500 or 1,000 seeds of the mixed crop seed and of the adulterant freed from other impurities. The crop seed and the adulterant are then

separated and their relative number determined by count.

Seed suspected of having lost its vitality, due to age or unfavorable conditions of harvesting, should be tested for its ability to germinate.

The percentage of seed that will grow can easily be determined by means of the simple tester shown in figure 19. Two dinner plates and a piece of canton flannel or some other similar cloth about twice the size of the plates are needed for this test. Blotting paper as well as cloth is suitable for this purpose.

The seeds which have been picked out should be thoroughly mixed and 100 or 200 seeds counted, just as they come, making no selection.

The cloth should be well moistened, one thickness being laid on one of the plates and the counted seeds placed on it, the other part of the cloth being spread over the seed, covered with the second plate, and kept at a temperature of about 70° F. On the second and each succeeding day the sprouted seeds should be taken out and counted.

The periods during which the crop seeds discussed in this paper germinate under favorable conditions are as follows: Clovers and

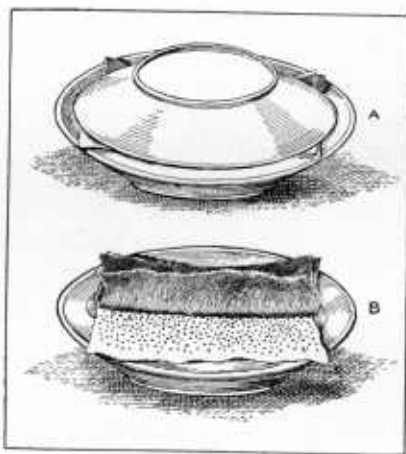


FIG. 19.—Homemade seed tester: A, closed; B, open.

alfalfa between the 3d and 6th days, timothy and redtop between the 5th and 8th days, meadow fescue and awnless brome-grass between the 5th and 10th days, orchard grass and rye-grasses between the 6th and 14th days, and Kentucky bluegrass between the 14th and 28th days. Many seeds which germinate slowly, including those of most of the grasses, require an alternating temperature and should be kept at about 70° F. for eighteen hours and 86° F. for six hours each day.

Samples of seed suspected of being adulterated can be sent to the Seed Laboratory, Department of Agriculture, Washington, D. C., for examination for adulterants. The presence or absence of adulterants will be reported upon at once. The determination of the quantity of the adulterant is likely to delay the report.

Residents of Missouri may send samples to the Seed Laboratory, Agricultural Experiment Station, Columbia, Mo.; those of Nebraska may address samples in the same way to the station at Lincoln, while those of Oregon may address the Seed Laboratory of the station at Corvallis. No charge is made for any of these tests.

SUMMARY.

(1) Serious and intentional adulteration of important forage-plant seeds is frequently practiced. Seed is sometimes misbranded.

(2) It is possible for purchasers to detect most kinds of adulteration or misbranding of farm seeds.

(3) In detecting adulteration it is necessary to know what kinds of seeds are subject to adulteration, the means employed in adulteration, and the distinguishing characters of both the crop and the adulterant seeds.

(4) A cheap magnifier suffices in distinguishing crop seeds from other kinds of seeds used as adulterants.

(5) A simple germinating test discloses the use of dead crop seed as an adulterant.

(6) The illustrations used in this bulletin were prepared especially to enable purchasers of farm seeds to distinguish seeds subject to adulteration and those used as adulterants.

(7) It is not the purpose of the bulletin to enable one to determine the extent of adulteration in each instance, but rather the more important fact of its existence.

(8) A little effort on the part of the purchasers of seeds directed to the detection of adulteration or misbranding will prevent many instances of crop failure.

(9) It is advisable to make tests for adulteration at home; otherwise the suspected seed may be sent to the Seed Laboratory at Washington or to the cooperative laboratories in Missouri, Nebraska, or Oregon. A report on the matter of adulteration will be made promptly and without charge.

